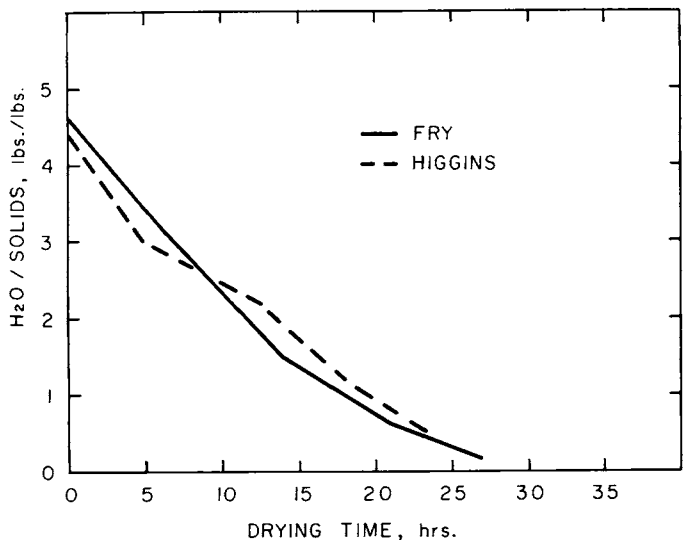

Fig. 3. Drying rate curves for two varieties of muscadine grapes dried in a natural convective solar dryer.

for whole grapes. A deseeder for muscadine grapes has been designed and built and is now undergoing further testing and modification.

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PRETREATMENT FOR SOLAR AND HOT-AIR DRIED MUSHROOMS

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Abstract. **Studies were conducted on pretreatments to reduce bacteria and preserve color of solar and hot-air dried mushrooms. Pretreatments included 1) dipping washed whole mushrooms in aqueous solutions of sodium hypochlorite, 2) slicing the dipped mushrooms, and 3) dipping the sliced mushrooms a second time in some other antimicrobial agent (methyl paraben, potassium sorbate, sodium benzoate or sorbic acid), with sodium bisulfite. Hypochlorite dips were effective in reducing bacteria in washed whole mushrooms. Additional agents were needed for reducing bacteria in solar and hot-air dried slices and varied in effectiveness. Color of dried mushrooms improved when they had been pretreated with sodium bisulfite.**

Fresh and canned mushrooms, used extensively by U. S. consumers, are produced domestically. However, all dried mushrooms except for a small quantity that are freeze-dried are imported. Compared with fresh or canned, dried foods can conserve energy through lower weight. Solar drying conserves fossil fuels in the drying process. Also, dried mushrooms require less energy for transportation and storage since they require little refrigeration.

Dried mushrooms for food use should have low bacteria count, proper color and good flavor. Blanching prior to hot-air drying at 65.6°C was suggested by Cruess and Mrak (4), but this method of reducing bacteria darkens the color. While dark mushrooms are preferred in England, the U.S. consumers prefer a very light tan or gray product. Recently Komanosky, et al. (6) studied pretreatments for hot-air dried mushrooms. Pretreatments were required and 2 stages of drying were necessary to produce products low in bacteria. The second stage for this method required temperatures of 76.7 to 82.2°C. Brunell, et al. (2) found mushrooms dried above 65.6°C had slight burned flavors.

A market presently exists for dried mushrooms incorporated with other dried foods but total bacteria plate counts must be minimal. Acceptable freeze-dried mushrooms have been reported with bacteria plate counts in the range of tens to hundreds of thousands/g (7). Our study developed pretreatments to reduce bacteria count in both conventionally hot-air and solar dried (A.D. and S.D.) mushrooms, while preserving color and flavor.

Materials and Methods

Drying Equipment

Hot-air dryer. An atmospheric pressure, forced draft, pilot scale, tray-type conventional hot-air dryer described by Wagner, et al. (10) was used.

Florida Solar Energy Center (FSEC) dryer. A solar dryer with two manually adjustable planar reflectors and forced air circulation described by Bryan, et al. (3) was used.

Mushrooms. All mushrooms used in these tests were obtained from the Ralston Purina plant at Zellwood, Florida. They had been graded and were ready for the fresh market. These mushrooms were usually stored overnight at 1.7°C before pretreatment.

[1]Southern Region, Science and Education Administration, U. S. Department of Agriculture. For metric conversions, see table at the front of this volume. Mention of a trademark or proprietary product is for identification only and does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of others which may also be suitable.

Tests

Chlorine pretreatments. Freshly washed mushrooms (908 g) were submerged in 2.470 *l* of deionized water with sufficient sodium hypochlorite to result in concentrations of 100, 200, 300, 400 and 800 ppm Chlorine (Cl_2) for periods of 1, 5, 10 and 15 min. Residual Cl_2 in the liquid was determined after each test and total aerobic bacteria plate counts were made. In addition, 3 A.D. samples were prepared from mushrooms dipped 10 min in solutions containing 200, 400 and 800 ppm Cl_2. Dried samples were ground and screened and the fraction through an 0.417 mm opening but retained on an 0.147 mm opening was used for flavor evaluations.

Sulfur dioxide pretreatments. Freshly washed and sliced mushrooms (1929 g) were submerged 10 min in 5200 g of sodium bisulfite solutions containing 0, 200, 400 and 600 ppm sulfur dioxide (SO_2). Mushrooms were dried in the conventional hot-air dryer for 5 hr at 62.8°C. The through 20 mesh on 35 mesh screens (<.417>.147 mm) fraction of the ground dried sample was used for reflectance and flavor evaluations.

Other pretreatments. Whole mushrooms were washed and submerged in solutions containing 100 ppm Cl_2 for 10 min. They were drained, sliced and submerged another 10 min in one of the following solutions: 1) 600 ppm methyl paraben with 600 ppm SO_2; 2) 600 ppm potassium sorbate with 600 ppm SO_2; 3) 600 ppm sodium benzoate with 600 ppm SO_2, 4) 200 ppm sorbic acid with 200 ppm SO_2. All pretreated samples were A.D. and S.D. except those treated with sodium benzoate which were only S.D. After drying, samples were analyzed for total aerobic bacteria plate count.

Other pretreatments tested were: 1) Blanching washed whole mushrooms for 5 min in steam before slicing and drying. 2)Dipping washed whole mushrooms for 10 min in water before slicing and drying. 3) Dipping sliced mushrooms (previously washed and dipped in 100 ppm CL_2) for 10 min in ascorbic acid solutions (200 and 600 ppm) before drying.

Analyses

Total aerobic plate counts. Freshly washed mushroom samples were held at −17.8°C, while dried samples were held at 1.7°C prior to plate counts using procedures described by the AOAC (1).

Reflectance. X, Y and Z reflectance measurements (5) were made on the (<.417>.147 mm) fraction of ground dried mushrooms. A Signature Model Color-Eye (Instrument Development Laboratories, Attleboro, Mass.) with a white daylight "C" reference standard was used for these measurements.

Chlorine concentrations. Chlorine concentrations were determined on the sodium hypochlorite solutions by an Iodometric method (7).

Flavor. Nine g samples of ground (<.417>.147 mm) dried mushrooms were stirred in 600 ml of deionized water for 5 min with a counter-rotating mixer. The mushroom suspension was then filtered through cheesecloth. Trained tasters familiar with mushroom filtrates were provided 2 samples and asked to indicate preference.

Results and Discussion

Only one combination of Cl_2 and SO_2 pretreatment with sorbic acid gave satisfactory reduction of bacteria for both A.D. and S.D. samples. Reflectance (indicative of color) of the dried mushrooms indicated they were darker than imported samples. These pretreatments produced dried mushrooms with reduced bacteria and good flavor but another pretreatment for color preservation is required to achieve the more desirable, lighter color.

In 2 tests on Cl_2 pretreatment of washed whole mushrooms bacteria were reduced as dip time and/or Cl_2 concentration increased (Table 1). Analysis of variance on test 1 showed dip time was significant [95% confidence level (C.L.)]. Test 2 included longer dip times and lower Cl_2 concentrations. Test 2 indicated both dip time and Cl_2 concentration had significant effects on bacteria reduction (99% C.L.). The data show 100 ppm Cl_2 for 5 to 15 min could reduce bacteria from 92.4 to 94.1%. Most efficient use of Cl_2 (based on residual Cl_2 in spent solutions) was obtained with 100 ppm Cl_2.

Table 1. Percent remaining bacteria (total aerobic plate count) in 2 tests of washed mushrooms after dipping in sodium hypochlorite solutions.

Cl_2 conc (ppm)	Test 1[z]			Test 2[y]		
Dip time (min)	200	400	800	100	200	300
1	92.6	81.7	1.4			
5	48.7	9.7	1.1	7.6	6.3	4.7
10	3.3	1.2	1.0	6.2	4.4	2.5
15				5.9	2.6	1.2

[z]Initial plate count was 32x10[6].
[y]Initial plate count was 228x10[6].

In comparisons of pretreatments for color preservation, statistical analyses of X, Y and Z reflectance values showed controls without pretreatment were significantly lighter than samples treated with ascorbic acid, or steam blanched. The X, Y and Z reflectance values for 200, 400 and 600 ppm SO_2 pretreated samples, compared statistically with their controls (0 ppm SO_2) indicated, the SO_2 pretreated samples were significantly lighter in color. In other tests comparing reflectance of SO_2 treated mushrooms with those treated with ascorbic acid, SO_2 was again found better for preserving color. Although SO_2 pretreated mushrooms were lighter than controls, they were not as light as dried mushrooms imported from Taiwan.

As expected with both A.D. and S.D. samples, reflectance values increased (closer to the white standard, 100) as pretreatment concentration with SO_2 increased. Table 2 shows reflectance values for an imported reference sample and A.D. and S.D. mushrooms pretreated with two concentrations (200 and 600 ppm) of SO_2. Wagner, et al. (11) previously showed that S.D. mangos, nectarines and peaches had to be dipped in higher SO_2 concentrations than their A.D. counterparts to achieve the same SO_2 retention in the final product. Thus, these results with mushrooms indicated

Table 2. Effect of sulfur dioxide pretreatment on reflectance values[z] of hot-air and solar dried mushrooms.

SO_2 conc (ppm) in dip[y]	X	Y	Z
Air-dried			
200	34.5	30.5	20.6
600	38.0	33.6	21.6
Solar dried			
200	31.0	27.8	19.2
600	33.0	29.1	19.4
Imported sample	42.5	38.3	26.9
White standard	100	100	100

[z]X, Y and Z reflectance values are the average for three samples of ground (<.417>.147 mm) dried mushrooms.
[y]The SO_2 treated samples were all pretreated with a 100 ppm Cl_2 dip.

a similar trend, as 600 ppm SO_2 pretreatment for the S.D. samples gave reflectance values approaching those of the 200 ppm SO_2 pretreated A.D. sample.

The Cl_2 pretreatment usually reduced bacteria counts, but left an unpleasant flavor in the dried mushrooms except at the lowest concentration tested (100 ppm). Flavor preferences for A.D. mushrooms with varying concentrations of Cl_2 and SO_2 showed the following: 1) the water dipped control was preferred over all Cl_2 pretreated samples at a 99% or better C.L. 2) Flavor of samples pretreated with all concentrations of SO_2 studied, was preferred over untreated controls at a 95% or better C.L.

Reduction in bacteria counts (98 to 99%) for A.D. mushrooms were obtained when Cl_2 and SO_2 pretreatments were used. These results are shown as tests 1 and 2 in Table 3. S.D. mushrooms, following these pretreatments, had bacteria counts greater than their original values. This increase in bacteria count indicated a need for additional antimicrobial treatment. Second dips in potassium sorbate (600 ppm), methyl paraben (600 ppm) and sorbic acid (200 ppm) resulted in 1% or less remaining bacteria for A.D. samples. However only sorbic acid (200 ppm) gave comparable results for S.D. samples. Final plate counts in this test were 39,000/g for A.D. and 23,000/g for S.D. Moisture content for these samples were 5.8% for A.D. and 9.5% for S.D. These values and others, when compared with bacterial reduction in the dried product did not indicate an optimum moisture content (water activity) for bacterial reduction in mushrooms as has been found with other products (9).

Table 3. Percent remaining total aerobic plate count of pretreated dried mushrooms.

Test	Pretreatment[z]	Hot-air	Solar
1.	200 ppm SO_2	1.6	+[y]
2.	600 ppm SO_2	0.6	+
3.	600 ppm potassium sorbate	0.1	+
4.	600 ppm methyl paraben	0.7	+
5.	600 ppm sodium benzoate	—	+
6.	200 ppm sorbic acid	0.1	0.1

[z]All pretreatments included a 100 ppm Cl_2 dip; tests 3, 4 and 5 had 600 ppm SO_2 dip; test 6 had 200 ppm SO_2 dip.

[y]+ indicates plate counts of dried samples were higher than original values before drying.

In conclusion Cl_2 and SO_2 pretreatments can be used to produce A.D. mushrooms with reduced bacteria concentrations. Equivalent bacterial reductions in S.D. mushrooms required sorbic acid (200 ppm) combined with SO_2 (200 ppm) pretreatments. Although SO_2 pretreatment preserved color better than ascorbic acid, additional pretreatments are necessary to obtain the desirable lighter color of imported dried mushrooms.

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PROTEIN EXTRACTION FROM AQUATIC WEEDS

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Abstract. **Five aquatic weeds** (Potamogeton illinoensis, Eichhornia crassipes, Pistia stratioties, Hydrilla verticillata, **and** Typha spp) **were harvested from Central Florida lakes and extracted with hot dimethylsulfoxide (DMSO). The DMSO extracts were analyzed for ethanol-precipitable proteins. Pondweed** (P. illinoensis) **contained the highest amount of extractable protein (5% of dry matter). Water hyacinth** (E. crassipes) **contained about 2%, and water lettuce** (P. stratioties), **hydrilla** (H. verticillata) **and cattails** (Typha spp) **contained less than 1% extractable protein. About 2½ times as much protein was extracted from pondweed leaves with DMSO as with an aqueous buffer. Acid hydrolysates of aqueous extracted proteins from pondweed leaves and water spinach** (Ipomea aquatica) **had similar amino acid levels which were comparable to levels in leaf proteins reported from other sources. Acid hydrolysates of DMSO-extracted proteins had high levels of most of the amino acids. However, methionine and cystine were barely detected in these hydrolysates. Loss of these amino acids was attributed to oxidation by contaminating DMSO during acid hydrolysis. Lysine, arginine and tyrosine were lower in hydrolysates of DMSO-extracted proteins than of aqueous-extracted proteins.**

Aquatic weeds are presently controlled in Florida by three techniques: chemical, biological and mechanical (7).

[1]Southern Region, Science and Education Administration, U. S. Department of Agriculture. For metric conversions see table at the front of this volume. Mention of a trademark of proprietary product is for identification only and does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval of the product to the exclusion of others which may also be suitable.

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